Highland Lake (Bridgton) Watershed Based Plan

Prepared for the

Maine Department of Environmental Protection

by Cumberland County Soil and Water Conservation District

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DOCUMENT PURPOSE

The purpose of this document is to outline a general strategy for NPS implementation in the watershed to help restore the water quality of Highland Lake. Under the EPA National NPS 319 Program Guidance, States need a watershed-based plan meeting EPA Guidance in order to use "incremental 319 funds" to implement management measures to help restore an impaired (TMDL) waterbody.

PLAN SCOPE

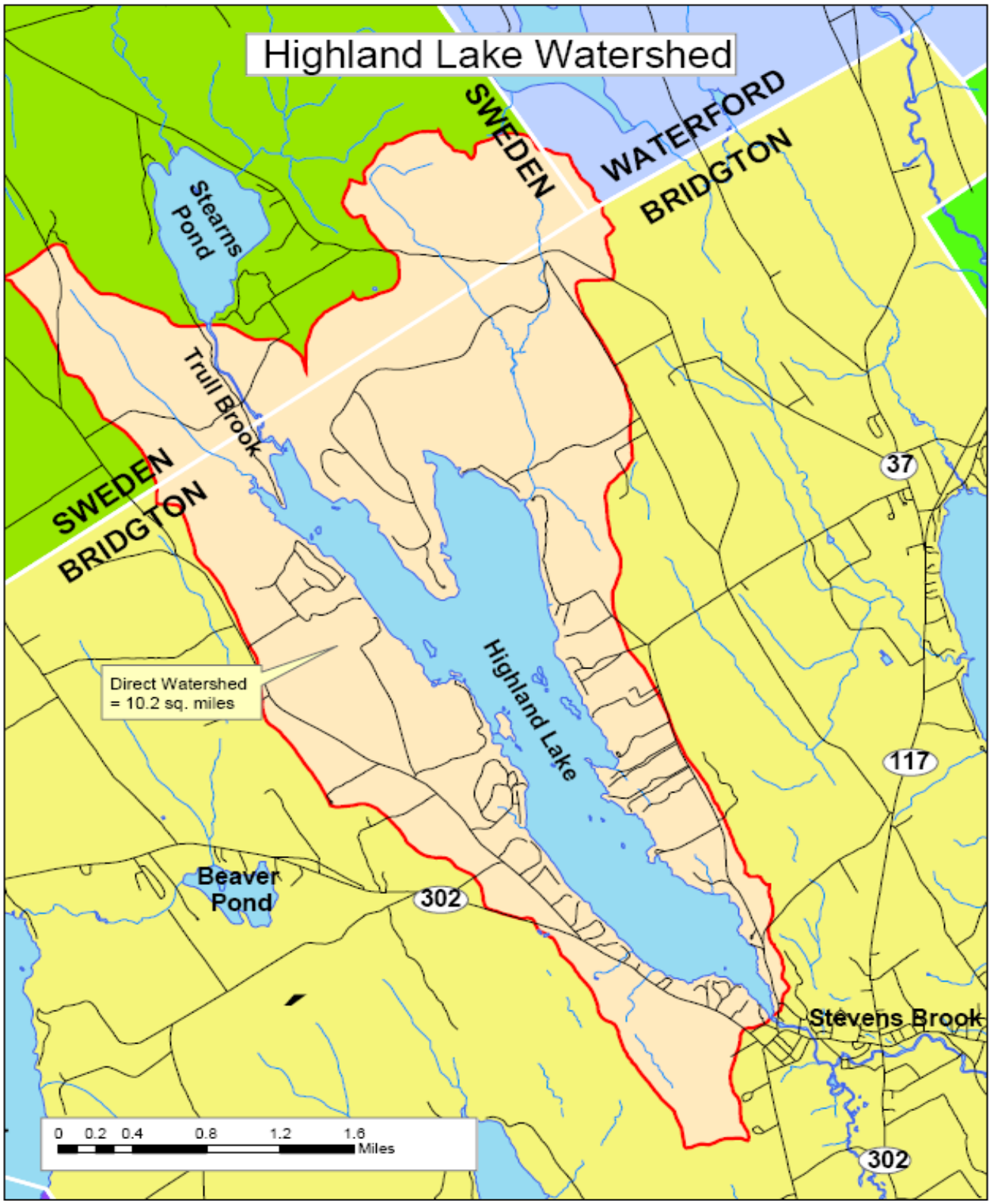
The scope of this plan describes actions that can reasonably be accomplished in an aggressive on-the-ground effort within a ten-year timeframe (2005 to 2014) in the Highland Lake Watershed in Bridgton, Sweden & Waterford. This plan integrates the analysis and recommendations laid out in the Highland Lake (Bridgton) PCAP/TMDL report (MDEP 2004), which outlines the need for a 27.5% reduction in phosphorus (162 kg) in order to address actual in-lake average annual TP concentration and the potential future watershed development. The ten-year focus addresses an interim goal of an estimated 16% reduction (95.5 kg) in watershed phosphorus loading.

WATER QUALITY OBJECTIVE

Implement BMPs in the watershed to achieve an estimated 16% reduction in watershed phosphorus loading in order to improve the water quality so that the trophic state of Highland Lake will be stable or decreasing (attaining Class GP-A water quality criteria (38MSRA 465-A(b)). MDEP designated Highland Lake on the 303(d) TMDL list as an impaired waterbody because of a declining trend of dissolved oxygen levels. If the lake exhibits a stable or improving trend for dissolved oxygen, then DEP could find the lake is attaining State water quality standards and remove Highland Lake from the TMDL list.

WATERSHED DESCRIPTION

The Highland Lake Watershed is a 1,334-acre waterbody located in the Town of Bridgton in Cumberland County, southwestern Maine (see Figure 1 page 2). Highland Lake has a direct watershed area of 10.2 square miles (including Sweden and Waterford in Oxford County); a maximum depth of 49 feet, a mean depth of 20 feet; and a flushing rate of 0.91 flushes per year. The total Highland Lake watershed drainage area, with subwatersheds, is 20.4 square miles. The lake is drained at its outlet by Steven's Brook, which flows southeasterly into Long Lake in Bridgton. The Maine Department of Inland Fisheries and Wildlife manages Highland Lake as


Highland Lake Watershed
SWEDEN
WATERFORD
BRIDGTON
Stearns Pond
Trull Brook
SWEDEN
BRIDGTON
Direct Watershed
= 10.2 sq. miles
Highland Lake
37
117
Beaver Pond
302
Stevens Brook
302
0 0.2 0.4 0.8 1.2 1.6
Miles

primarily a warmwater fishery (smallmouth bass and white perch) with limited holdover of stocked brown trout.

The dominant human uses of the Highland Lake shoreline are residential and recreational, including boating, fishing and swimming/beach use. A town operated public boat launch is located at the southern tip of the lake off Highland Road in Bridgton. There are no commercial camps, campgrounds, marinas, or condos on the lake. The shoreline is moderately developed. Of the 351 shorefront residences, approximately 85% are seasonal and 15% are year-round, and approximately 86 are undeveloped. Based on estimates from the 2001 census, a total of 4,883 people currently reside in Bridgton. The population of Bridgton increases by approximately 50% in the summer months. Between 1990 and 2000, Bridgton's population has increased by 13.4%. Some of the population increase in Bridgton over this time period involves conversions from seasonal to year-round residences.

Water quality monitoring data for Highland Lake including temperature, oxygen, Secchi disk transparency, color, pH, conductivity, phosphorus, alkalinity and Chlorophyll-a has been collected regularly since 1976. Together, these data document an overall trend of increasing trophic state, in direct violation of the Maine DEP Class GPA water quality criteria requiring a stable or decreasing trophic state. Recent dissolved oxygen profiles in August and September show DO depletion in the deep areas of the lake at or near zero levels. This can be attributed to the contribution of phosphorus that is prevalent in area soils and effectively transported via stormwater. Trout and other coldwater fish require oxygen levels greater than 5 ppm to survive and even higher levels (7-8 ppm) to grow and reproduce. Since dissolved oxygen levels in Highland Lake's hypolimnion fall far below this level during most summers, it is likely that the lake has experienced a moderate to severe reduction in coldwater fish habitat (MDEP, et. al. 2004).

The Maine Department of Environmental Protection (MDEP) recognized Highland Lake's downward water quality trend and listed Highland Lake as a non-attainment lake in their *1996, 1998, 2000, 2002, &2004 Integrated Water Quality Monitoring and Assessment Reports*. In 1998, MDEP also placed Highland Lake on the state's "Nonpoint Source Priority Watersheds List" and on the list of lakes "Most at Risk from Development".

Nonpoint source pollution is the main reason for declining water quality in Highland Lake. Excessive soil erosion in lake watersheds can have far-reaching water quality consequences. Soil particles transport phosphorus, which essentially "fertilizes" the lake and decreases water clarity. Studies on lakes in Maine have also shown that as lake water clarity decreases, lakeshore property values decline. Excess phosphorus can also stimulate the growth of aquatic invasive plants such as variable leaf milfoil, which fortunately has not yet been found in Highland Lake.

PRIOR WORK

The Lakes Environmental Association (LEA) has been working to protect Highland Lake for over 30 years by performing comprehensive water quality testing, providing technical assistance to landowners, carrying out watershed education workshops and trainings, and producing educational newsletters and brochures. The LEA staff and Board of Directors have developed excellent rapport with the watershed towns of Bridgton, Sweden and Waterford. LEA has built

this by providing technical assistance and review of construction projects, aid with enforcement issues, help with ordinance development and land use planning.

From 1998 to 2000, LEA completed the Highland Lake Watershed Project. This study documented significant water quality impairments to Highland Lake, recommended steps for restoration and implemented BMPs on some of the most problematic sites in the watershed. The project was primarily funded by the US EPA, under section 319 of the Clean Water Act.

The project identified erosion sites within the watershed utilizing the land use coverage based, "Phosphorus Hotspots Model," a one-day rapid survey of the roads and watershed during a significant rain event, and the LEA's "Clean Lake Check-Up Program," which offered property owners free site visits and consultations throughout the project. This service encouraged individuals and road associations to review their own property and ask for assistance. This method helped raise awareness and identify and fix smaller problem areas.

As a result of the project, six high priority lake sites were reconstructed using various BMPs, including cross culverts, sumps, level lip spreaders, open-top culverts, broad based drainage dips, revegetation and ditching. Forty-two Clean Lake Check-Ups were conducted during the project period, of which nine were acted upon. Several demonstration sites were implemented and two non-functioning septic tanks on a small island were connected to a waste disposal system to eliminate effluent leaching into the lake.

From 2004 to 2005, the Cumberland County Soil and Water Conservation District began the *Highland Lake Watershed Improvement Project – Phase I* to significantly reduce erosion and export of sediment and phosphorus into Highland Lake. Conservation practices that reduce erosion and polluted runoff were installed at one residential site, engineering designs were completed for one town road site in Sweden, and technical assistance was provided to ten landowners.

In 2004, DEP completed a TMDL analysis, "Phosphorus Control Action Plan and Total Maximum Daily Load (Annual Phosphorus) Load Report - Highland Lake" available at the MDEP website http://www.maine.gov/dep/blwq/docmonitoring/tmdl2.htm.

NINE MANDATORY ELEMENTS

Although many different components may be included in a watershed plan, EPA has identified a minimum of nine elements that are critical for achieving improvements in water quality. EPA requires that these nine elements be addressed for watershed plans funded using incremental section 319 funds and strongly recommends that they be included in all other watershed plans that are intended to remediate water quality impairments. The following sections (A-I) lay out these nine elements.

A. Identify Causes & Sources

The lake's dissolved oxygen problems can be attributed to nonpoint source pollution (NPS) that washes into the lake from its surrounding watershed. Phosphorus, in particular, poses the greatest

NPS threat to Highland Lake. The August 2004 Highland Lake PCAP-TMDL Report highlighted the need to fix existing erosion sites, enhance shoreland zoning standards, and institute phosphorus standards for construction of camp roads.

A comprehensive land use inventory was undertaken to assist Maine DEP in developing the PCAP-TMDL report for the Highland Lake watershed. Watershed survey work, including shoreline and septic survey evaluations, were conducted by the Maine DEP-MACD-LEA project team to help assess total phosphorus reduction techniques that would be beneficial for the Highland Lake watershed. As part of this, LEA identified NPS pollution sites though GIS computer modeling (hot spots mapping) and field surveys. The field surveys were conducted during storm events and included assessment of many direct drainage nonpoint source (NPS) pollution sites that were not identified during a previous (1998-2000) Highland Lake Watershed Project.

In total, 64% of the shoreline sites documented in the draft PCAP-TMDL survey of 351 shoreline lots were deemed to need some enhancement. 17% (60) were high impact sites, 47% (165) were medium impact and 36% (126) were low impact. LEA hot spots mapping (see Attachment A) also identified areas of the shoreline as high priorities for potential phosphorus inputs.

The August 2004 PCAP/TMDL identified that a phosphorus load reduction of 27.5% (or 162 kg phosphorus/year) is needed to achieve stable or increasing trend in dissolved oxygen to attain Class GPA water quality standards. Extensive watershed improvements will be needed to achieve this TMDL load allocation. Since this plan was prepared to outline needs over a 10 year timeframe, an interim target is needed.

Therefore, the following interim target was set. An interim goal potentially achievable in a 10 year timeframe is a loading reduction to achieve a decrease of 1.5-1.75 ppb total phosphorus concentration in the lake. This includes 0.75-1 ppb for current watershed loading and 0.75 ppb allowance to offset future development. On a mass basis this corresponds to reduction in loading of 88-103 kg (15 -17.5 %) from the estimated direct watershed loading (588kg).

In order to achieve this interim target phosphorus load reduction of 16%[1] (or 95.5 kg phosphorus/year), the following, specific sources will need to be addressed:

- Shoreline Development – approximately 70% of the medium density residential sites and 100% of the camp and private road issues will need to be addressed.
- Non-shoreline Development – approximately 100% of the state and town road issues and 40% of the medium density residential issues will need to be addressed.
- Forestry – approximately 50% of the operated forestland will need to be addressed.

The above listed sources are estimated to contribute 16% of the phosphorus load to Highland Lake.

[1] The framework for the estimates can be found in Attachment B, which utilized "Table 1: Highland Lake Direct Watershed - Land Use Inventory and P-Loads," from the August 2004 Highland Lake PCAP-TMDL Report.

B. Estimate Load Reductions from Planned Management Measures

Maine DEP used "A Relational Method for Estimating Needed Phosphorus Load Reductions for Lake Watersheds" to estimate load reductions from planned management measures, described by Jeff Dennis in Attachment B. This method starts by comparing current and target in-lake phosphorus concentrations to estimate the needed percent reduction for in-lake phosphorus concentration. In-lake concentration tends to be proportional to the external phosphorus load, once internal recycling is factored out. Therefore the percentage of external load reduction needed can be based on the reduction needed for in-lake concentration. Next, the method considers land use and watershed survey information to estimate the relative contribution of different phosphorus sources to the current load expressed as a fraction of total load. Then, load reductions are estimated based on the anticipated extent of BMP usage and expected BMP efficiency.

The interim phosphorus reduction target is 16%. Refer to Attachment B for a description of the method and the results for Highland lake, which utilized "Table 1: Highland Lake Direct Watershed - Land Use Inventory and P-Loads," from the August 2004 Highland Lake PCAP-TMDL Report.

Given the management measures recommended for the identified sources, it is estimated that BMP efficiencies will average approximately 47%. Given this average efficiency, then the planned BMPs will provide a total estimated load reduction of 16% or 95.5 kg phosphorus/year. The 47% average is a conservative estimate that incorporates the median values derived from 145 monitoring studies conducted through the United States and Canada (Winer, 2000) evaluating the median phosphorus removal efficiencies for stormwater treatment practice groups, as follows: infiltration practices (~80%); filtering practices (~59%); stormwater wet ponds (~51%); water quality swales (~34%); and stormwater dry ponds (~19%).

C. Description of Management Measures

The Highland Lake PCAP-TMDL Report (MDEP 2004) highlighted the need to fix existing erosion sites, enhance shoreland zoning standards, and institute phosphorus standards for construction of camp roads. The implementation needs are as follows:

SHORELINE DEVELOPMENT - RESIDENTIAL

70% of the medium density residential development will need to be addressed. In order to ensure the most productive use of funds, remediation efforts should be focused on high (60) and medium (165) impact sites identified as part of the shoreline survey completed during the PCAP-TMDL effort. Management practices will include establishment or enhancement of vegetated buffers and installation of infiltration trenches, dry wells and/or runoff diverters as deemed appropriate to address the needs of the identified site.

SHORELINE DEVELOPMENT – CAMP/PRIVATE ROADS

100% of the camp and private road issues will need to be addressed. In order to ensure success, the first sites to be dealt with should be selected based on potential impact to the lake and landowner interest. Completed sites should be highlighted in the LEA newsletter as well as the

local papers and landowners should be commended for their efforts to remediate erosion on their roads. There are approximately 60 private roads in the shoreline area. Many are in pretty good shape and most have organized road associations. Management practices will include improving road drainage through better road material, culverts, ditches, turnouts, water quality ponds, level lip spreaders as well as crowning and proper grade stabilization as deemed appropriate to address the needs of the identified site.

NON-SHORELINE DEVELOPMENT – STATE AND TOWN ROADS

Approximately 100% of the state and town road issues will need to be addressed. LEA or CCSWCD should apply to MDOT's Surface Water Quality Protection Program to ensure that state road sites are remediated. Watershed Towns should be made aware of all identified town road issues in case some erosion issues can be addressed as part of routine maintenance. Town Road sites should be addressed in order of potential impact to the lake. The largest obstacle for completing Town Road sites is the fact that the watershed Towns are quite small. Therefore, the public works departments usually have to hire a contractor to get work done, which can create a financial burden for the Towns. Management practices will include improving road drainage through better road material, culverts, ditches, turnouts, water quality ponds, level lip spreaders as well as crowning and proper grade stabilization as deemed appropriate to address the needs of the identified site.

NON-SHORELINE DEVELOPMENT - RESIDENTIAL

Approximately 40% of the medium density residential issues will need to be addressed. LEA hot spots mapping and storm event assessments should be utilized to focus remediation efforts on the highest impact non-shoreline residential areas. Management practices will include establishment or enhancement of vegetated buffers and installation of infiltration trenches, dry wells and/or runoff diverters as deemed appropriate to address the needs of the identified site.

FORESTRY

Approximately 50% of the operated forestland will need to be addressed. Management practices will include an education campaign on forestry-related nonpoint source controls. Specifically, this will be accomplished through providing training to forestland operators through a "Certified Logging Professional" program. Promote that lumber companies become Forest Stewardship Council (FSC) certified. In addition, code enforcement officers should be made aware of all state laws and town ordinances that apply to the operation of forest land and on-site training should be provided in site assessment of forest operations. Lastly, financial incentives for sustainable yield forestry should be explored, including the purchase of development rights by land trusts or the town.

ENHANCEMENT OF LOCAL ORDINANCES

Management practices will include improving shoreland zoning standards and implementing simple phosphorus standards for non-shoreline development as well as implementing town comprehensive plans and phosphorus control ordinances. In addition, effort will be made to maintain strong enforcement of existing and improved standards.

D. Description of Technical & Financial Assistance Needed

It is estimated that $1.5 million will be needed to address the pollutant loading in this watershed. The potential exists for this funding to come from federal section 319 and local cash and in-kind match. The *Highland Lake Watershed Improvement Project – Phase I* is $98,009 in section 319 funds, and matched by $65,529 in local cash and in-kind donations. Additional local cash and in-kind match will account for the water quality monitoring that will be carried out by the LEA under the direction of the Volunteer Lake Monitoring Program (VLMP) and the Maine Department of Environmental Protection. VLMP, LEA and MDEP personnel will then analyze water quality data.

Cumberland County SWCD will continue to serve as the 319 grant project sponsor and be responsible for the coordination and implementation of all grant project activities.

Maine Department of Environmental Protection will administer project funding, serve as the project advisor, participate on the steering committee, provide water quality data analysis, and assist with the volunteer training and technical follow-up of identified sites.

US Environmental Protection Agency will provide project funding and guidance.

Lakes Environmental Association will participate on the steering committee, coordinate volunteer contacts for demonstration sites, advertise project activities through their newsletter, carry out educational programs with Bridgton and Waterford schools, perform water quality monitoring and data analysis, assist with town outreach, organize conservation practices tour and complete shoreline and road surveys to assess maintenance needs and erosion problems.

Towns of Bridgton, Sweden and Waterford will have a representative serve as liaisons for lake issues, facilitate presentations with each town, and participate in applicable steering committee meetings and project activities. Each town will also contribute in-kind labor to mitigate erosion issues on identified town road sites and carry out enforcement of state laws and local ordinances as they apply to water quality protection. Each town will also contribute cash match to the LEA for water quality monitoring and analysis.

E. Information & Education Outreach

Education is at the heart of any successful implementation project. Project activities will be showcased in presentations at the Lakes Environmental Association's Annual Meeting, which will include before and after slides of the road and residential sites. Cumberland County SWCD staff will develop flyers and press releases to advertise the availability of technical assistance and other project events. Project brochures will be produced, as needed, that include before and after pictures of the conservation practices.

Lakes Environmental Association offers outreach education programs throughout the year. The goal of the outreach education series is to promote understanding of environmental and watershed issues in the Lakes Region. The Lakes Environmental Association will continue to take the lead in efforts to protect the lake through educational endeavors such as:

- Publishing a tri-annual newsletter and maintaining an instructive website;
- Providing educational programs in the local schools;

- Hosting an annual meeting, which provides a forum for dialogue and presentations regarding pertinent lake issues;
- Providing adult education programs and local seminars;
- Providing ongoing technical assistance for property owners and municipalities;
- Partnering with the watershed Towns of Bridgton, Sweden and Waterford to increase their ongoing maintenance programs on Town roads. Conducting road and shoreline inspections in an educational manner in order to facilitate landowner compliance with both local shoreland zoning ordinances and state erosion control laws;
- Maintaining a presence within the watershed and with the land use decision makers in all of the watershed municipalities; and
- Monitoring the water quality of Highland Lake and making this data available to watershed residents.

F. Implementation Schedule

2005-2007: Implement NPS Project #2005R-10 Highland Lake Watershed Improvement Project – Phase I (Bridgton)

2007: CCSWCD, MDEP and LEA will assess watershed readiness for the next phase of an implementation project. Grant work plan will be submitted to MDEP and, if funded, will commence in 2008.

2008-2010: Implement NPS Project – Highland Lake Watershed Improvement Project – Phase II (Bridgton)

2009: CCSWCD, MDEP and LEA will assess watershed readiness for the next phase of an implementation project. Grant work plan will be submitted to MDEP and, if funded, will commence in 2010.

2010-2012: Implement NPS Project – Highland Lake Watershed Improvement Project – Phase III (Bridgton)

2011: CCSWCD, MDEP and LEA will assess watershed readiness for the next phase of an implementation project. Grant work plan will be submitted to MDEP and, if funded, will commence in 2013.

2013-2015: Implement NPS Project – Highland Lake Watershed Improvement Project – Phase IV (Bridgton)

2014: CCSWCD, MDEP and LEA will assess whether additional on-the-ground implementation is needed. If needed, develop a workplan and secure funding for a Phase V NPS watershed project.

2005 –2014: Lakes Environmental Association will continue to provide education and outreach to watershed residents.

G. Milestones to Measure Progress Implementing Management Measures

By 2010, 100 residential sites and 32 road sites will be addressed. In addition, a Youth Conservation Corps Program will be established and the groundwork will be laid to establish enhanced water quality ordinances in the watershed towns.

By 2016, an additional 210 residential sites and 48 road sites will be addressed. Enhanced participation in the certified logger program and Forest Stewardship Council (FSC) certified owners. In addition, the enhanced local ordinances (shoreland and phosphorus) will be well established in the watershed towns.

H. Criteria to Determine Progress in Attaining WQ Standards & Load Reductions

Attaining Water Quality Standards

DEP will complete a trend analysis of dissolved oxygen data to assess progress in attaining water quality standards. MDEP designated Highland Lake on the 303(d) TMDL list as an impaired waterbody because of a declining trend for dissolved oxygen levels. If the lake exhibits a stable or improving trend for dissolved oxygen, then DEP could find the lake is attaining State water quality standards and remove Highland Lake from the TMDL list.

Load Reductions

The proposed BMPs are estimated to provide a reduction of about 95.5 Kg/ phosphorus/year based on the Relational Method for Estimating Required and Projected Phosphorus Load Reductions (see explanation in Attachment B). Field scale pollutant load reduction estimates will be completed for most BMP sites using EPA recommended methods. These field scale estimates will yield some useful indication of progress. However, the field scale estimates are not directly comparable to the Relational Method for Estimating Required and Projected Phosphorus Load Reductions, which is based on broad watershed-scale assessment.

I. Monitoring Progress Compared to Criteria

CCSWCD and DEP will periodically monitor progress as follows:

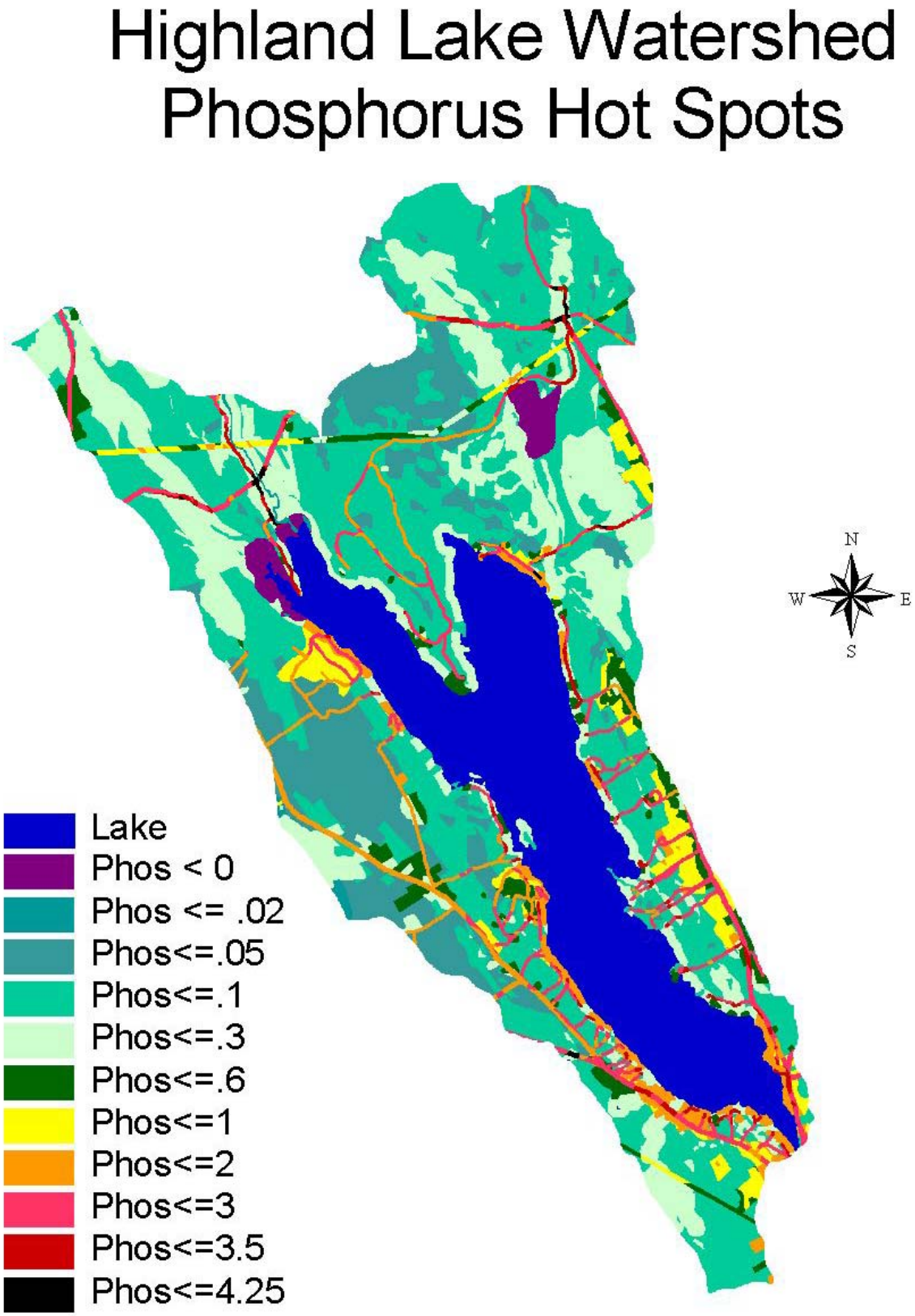
Attaining Water Quality Standards

Historically, the water quality of Highland Lake has been monitored via measures of Secchi disk transparencies, temperature, dissolved oxygen, chlorophyll a, pH during the open water months since 1976 (Maine DEP, LEA & VLMP). Continued long-term water quality monitoring of Highland Lake will be conducted bi-weekly, from May to October, through the continued efforts of LEA, in cooperation with VLMP and MDEP. In addition, annual baseline water quality sampling (dissolved oxygen- temperature profile, total phosphorus and chlorophyll-a) should be done, at a minimum, once during the early (May-June) and late summer (August-September) periods. Under this planned, post PCAP-TMDL water quality monitoring scenario, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Highland Lake. A post-TMDL status update (adaptive management) report will be prepared in 2010..

Load Reduction Estimates

CCSWCD will prepare a report documenting the estimated nonpoint source pollutant load reduction (sediment and phosphorus) that is achieved due to the implementation of the 319 funded conservation practices at NPS sites in the watershed. The methods to be used are described in the publication, "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual, Revised June, 1999, Michigan Department of Environmental Quality." Estimates will be prepared for all sites unless it is not feasible to apply the method on the site and supporting calculations will be attached.

Attachment A: Hot Spots Map



Attachment B

A Relational Method for Estimating
Needed Phosphorus Load Reductions for Lake Watersheds

Jeff Dennis, Division of Watershed Management, MEDEP

Given the nature of most Maine lake watersheds, which tend to be mostly forested, with most of the cultural activity being shoreline development accessed by a network of camp roads and rural, roadside residential development on a lower density network of town and state roads, it is difficult and often misleading to try to characterize phosphorus sources based on classic land use/export coefficient analysis. The development in these watersheds is anything but uniform, with phosphorus export being much more a function of the characteristics of each road segment and house lot than the areal extent of residential land use. Because of this, and also the fact that none of the residential export coefficients available in the literature were derived from data on this type of low density development, standard areal land use/export coefficient estimates of phosphorus load are likely to be inaccurate, or at least have a *very* wide margin of error.

In regard to phosphorus loading in impaired lakes in Maine, there are however two things that we can usually identify with some confidence. First, we usually have good enough information on in-lake phosphorus concentrations to define what the typical current phosphorus concentration (minus internal recycling issues) is in the lake and we also have a pretty good idea of what we would like that concentration to be. Since in lake concentration tends to be proportional to external phosphorus load once internal recycling has been factored out, we therefore know reasonably well what the target for percent reduction in external phosphorus load should be. Second, since we have usually completed a watershed survey to identify specific phosphorus sources, we have real information on what are probably the most important, actual, man-induced, nonpoint phosphorus sources to the lake. We do not know the absolute magnitude of any of these sources, but we do have a fairly good feel for their relative significance.

Since absolutes are so hard to quantify, we suggest working with percent reductions in various categories of phosphorus sources and BMPs. Refer to EXAMPLE on attached page.

1. Comparison of current lake P concentration (minus internal recycling consideration) and target P concentration gives best idea of necessary percent reduction in external load.
2. Use land use/watershed survey info to get a handle on the relative contribution of various types of phosphorus sources to the current load, expressed as a fraction of total load.
3. For each phosphorus source type that will be addressed (i.e. camp roads, town roads, agriculture, high export shoreline development, etc.) estimate what percent of that source type will be addressed by the project, expressed as a fraction of the total contributing "phosphorus sources".
4. For each phosphorus source type that will be addressed, make a best guess estimation of probable load reduction from the typical BMP systems that would be applied to a source, expressed as a fraction of the load from that source.
5. For each source type multiply the three fractions (from 2, 3,and 4) to get estimate of the portion of the total load that will be reduced by activities involving that land use.

6. Sum for all addressed source types to get an estimate of the expected reduction of total load, expressed as a fraction of the total load.
7. Compare to target percent reduction in 1.

Example

EXAMPLE: A Relational Method for Estimating Needed Phosphorus Load Reductions for Lake Watersheds

Jeff Dennis, MDEP

Source Type	Sub-type	fraction of total load	fraction addressed	expected BMP efficiency	load fraction reduced
Roads					
	high exp private	0.15	1.0	0.6	0.0900
	low exp private	0.07	0	0.3	0
	high exp public	0.07	0.5	0.6	0.021
	low exp public	0.06	0	0.3	0
Residential					
	high exp shore	0.07	0.4	0.4	0.0112
	low exp shor	0.02	0	0.1	0
	high exp wshed	0.08	0.2	0.4	0.0064
	low exp wshed	0.03	0	0.1	0
Commer/Ind					
	high exp C/I	0.05	1.0	0.6	0.0300
	low exp C/I	0	0	0.3	0
Forest					
	high exp forest	0.02	1.0	0.5	0.0100
	low exp forest	0.38	0		0
		1.00			0.1686

Expected Load Reduction = 17%

Current Lake [P]	18
Target Lake [P]	15
Target fraction load reduction	0.1667
Target % load reduction	17%

Example

Table 1: A Relational Method for Estimating Needed Phosphorus Load Reductions for Highland Lake Watershed – Bridgton

Source Type	Sub-type	Fraction of total load[2]	fraction addressed[3]	expected BMP efficiency[4]	load fraction reduced[5]
Ag & Forestry	Low intensity Hayland	0.088	0		0.000
	Orchard	0	0		0.000
	Operated Forest Land	0.179	0.5	0.75	0.067
Shoreline Development	Low density residential	0.014	0		0.000
	Medium density residential	0.060	0.7	0.40	0.017
	Septic systems	0.056	0		0.000
	parks (Public Boat Launch Area)	0	0		0.000
	Commercial	0.003	0		0.000
	Private/Camp Roads	0.031	1	0.40	0.012
Non-shoreline Development	Low Density Residential	0.036	0		0.000
	Medium Density Residential	0.143	0.4	0.40	0.023
	State/Town Roads	0.105	1.0	0.40	0.042
	Cemeteries	0	0		0.000
	Industrial	0.003	0		0.000
	Utilities	0.007	0		0.000
	Paved Parking Areas	0.007	0		0.000
	Commercial	0.005	0		0.000
	Institutional (Public)	0.007	0		0.000
	Gravel Pits	0	0		0.000
	Golf Course	0.005	0		0.000
Other	Inactively/Pass. Mngd Forest	0.099	0		0.000
	Wetlands	0	0		0.000
	Scrub Shrub	0.005	0		0.000
	Islands	0	0		0.000
	Other open water	0.002	0		0.000
	Surface Waters	0.150	0		0.000
		1			0.161
				Expected Load Reduction =	16%

Current Lake [P] ppm	10
Target Lake [P]	8.375[6]
Target Fraction Load Reduction	0.161
Target % Load Reduction	16%

[2] Land use/watershed survey info was used to determine relative contribution of phosphorus sources to the current load, expressed as a fraction of total load (from PCAP Table 1: Land Use Inventory & Total P Loads).

[3] This is the estimate of thepercent of source type to be addressed by implementation of this watershed-based plan, expressed as a fraction of the total contributing "phosphorus sources."

[4] "Best guess" estimation of probable load reduction from the typical BMP systems that would be applied to source, expressed as a fraction of the load from that source.

[5] For each source type multiply the three fractions (from 3, 4,and 5) to get estimate of the portion of the total load that will be reduced by activities involving that land use.

[6] See Page 6, paragraph 2.

REFERENCES

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